Master Poster List

Analysis of a Worker Assignment Model in a Lean Manufacturing Environment

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This paper describes an expansion of a multi-period worker assignment model for a lean production cell that produces a single product family. The hypothetical cell operates eight hours per day, twenty days per month and has six workers performing ten tasks. The model assigns the workers to tasks and determines the levels of additional training that may be necessary to meet customer demand, quality requirements, and cross-training provisions. The two main factors analyzed are the number of workers trained beyond two tasks and frequency of job rotation. Three levels of workers trained and three levels of job rotation frequency are evaluated. The three levels of worker training are two, four, and six workers trained on more than two tasks (the minimum to be considered cross-trained). The three levels of job rotation are eight, four, and two hour rotations per day. The solutions from the model are analyzed to determine the impact the two factors have on net present costs, quality costs, and training within the work month. The model expands upon the research of McDonald et. al., (2009) by allowing workers to be trained up more than a single skill level on tasks during the 20-day planning period and removing the budgetary constraint for training. The results of this model are expected to provide insight on the impact worker training and job rotation frequencies have on production line performance and provide guidance on training policies.

Neural Network-Based Classification of Speech under Stress using Nonlinear Spectral and Cepstral Features

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Analysis and detection of physiological stress at workplace in fields such as telecommunications, military operations, emergency medical services and law enforcement is important in assessing the ability of the worker and assigning tasks accordingly. Stress detection based on speech enables monitoring of stress nonintrusively and, in general, without the cooperation of the speaker. Speech-based stress analysis also has significant implications for national security and job screening. Other applications include detection of deception in speech based on the emotional state of the speaker, and implementation of natural-sounding speech synthesizers. For a speaker under stress– when the speaker is angry, fearful, sad etc. – increased activation of the sympathetic or the parasympathetic nervous system is observed to occur. This increased activation leads to change in heart rate and blood pressure, and also to tremor in muscle activity. Consequently, the articulatory and respiratory movements for speech production are affected. Studies have well established that variability introduced by stress or emotion contributes significantly to reduce severely speech recognition accuracy. Techniques for detecting the presence of stress could help improve the robustness of speech recognition systems. Although some acoustic variables derived from linear speech production theory have been investigated as indicators of stress, they are not always consistent. The majority of studies in the field of speaker stress analysis has concentrated on pitch, estimated vocal tract area profiles, acoustic tube area coefficients, mel-cepstral based parameters including mel-cepstral (MFCC), delta MFCC, delta-delta MFCC, and a new feature based on the autocorrelation of the MFCC's (AC-mel). Stress classification performances using these features were determined using separability distance metrics based classifier. It was shown that stress classification performance varied significantly depending on the vocabulary size and speaker population. However, MFCC and AC-mel performed better than delta-MFCC and delta-delta MFCC. Other acoustic features which have also been shown to be useful as indicators of speech under stress include fundamental frequency, phoneme duration and intensity, glottal source structure and vocal tract formants structure.The goal of the present work is to propose two spectral features, namely, Bark band spectral energy and significant spectral energy, for the task of stress classification. It is shown that these two spectral features outperform traditional cepstral (MFCC) features as potential stress sensitive relayers using the stressed speech database, called SUSAS, obtained from communication between flight controllers and fighter aircraft crew. Spectral energy in 17 bands of frequencies on Bark scale and 16 mel-scale warped cepstral coefficients were used independently for classifying the speech under stress. A neural network-based classifier based on Levenberg-Marquardt back-propagation algorithm was used for speaker-dependent stress classification to detect and classify angry, question and clear speech conditions. Preliminary results of matching features for a small set of utterances showed correct detection of speech condition in better than

83% of the cases using each set of features from Bark band energy and significant energy. MFCC features, on the other hand, showed close to 75% correct detection for the same utterances. Further tests are under way for more utterances and/or more speakers with the same set of speech conditions.

EMI Profile of High Speed Interfaces

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Gigabit interfaces rely on differential signaling to reduce unintended electromagnetic interference (EMI) at high frequencies. However, radiation from backplane connectors decreases signal integrity and reduces power delivered as frequency increases. We explore a novel approach of characterizing this radiation with mixed-mode S-parameters. Specifically, we focus on how differential- to common-mode conversion increases power radiated at high frequencies. The ideal differential signal is obtained when the two single-ended signals, v1 and v2, are out of phase by 180° so that their difference is maximized. Such structures are less prone to crosstalk and are more immune to interference since such disturbances would most often appear as the same sign in both v1 and v2 so that the differential signal v1-v2 would be unchanged. Mode conversion most often occurs when the symmetry between the lines is lost, by one line being longer, for example, causing energy to be transferred from the differential mode to the common mode. Our simulated and measured results agree that at frequencies above 10GHz, radiated power, measured in an anechoic chamber, is dominated by this mode conversion.

Smart Autonomous Vehicle in a Scaled Urban Environment

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Autonomous vehicles have become of increasing interest with researchers due to their potential to increase road safety and allow those with physical impairments the ability to drive. The focus of this project is the design of an autonomous control system such that a 1/14 scale vehicle (RC MAN TGX 26.540 6x4 XLX) can navigate a proportionally scaled roadway. The top level behavioral objective is for the vehicle to approach an intersection, halt at the stop line, execute a right turn, and stay within lane lines at all times. An OV7670 camera module is interfaced with two digital signal processors (TMS320C5515) to perform the image processing. The primary controller is implemented using a microcontroller (Stellaris LM4F120) and its output is received by a secondary controller housing power electronics for motor interfacing. The TMS320C5515 interfaces with the Stellaris LM4F120 through an I2C bus. The lane detection is implemented using Canny/Hough estimation of vanishing points, to generate an angle of correction by comparing the desired direction of travel to the current trajectory of the vehicle. Stop sign detection is implemented using histogram oriented gradients in a support vector machine for shape classification, which has an 80% detection rate in simulation. The controllers interface with vehicle motors to execute software-controlled speed and steering algorithms. The control loop is closed through the use of a rotary encoder to regulate vehicle speed. All of the control algorithms are based on kinematic and geometric theory.

A Qualitative Approach to Validity Analysis in Instrument Design

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It is essential for engineering students to possess information literacy and critical thinking skills to solve complex engineering problems. In engineering education, assessment of such skills has been a longstanding problem. In a separate study, the authors have developed the Critical Engineering Literacy Test, which consists of 20 selected-response items with 11 constructed-response items. The open-ended constructed response items required students to supply rationale for their selection(s) to the associated selected-response items. The objective of this study was to describe a process for using qualitative data (e.g., open-ended response questions) to provide validity evidence for the design of a selected-response instrument. Specifically, this study used the results of the qualitative analysis to support findings from classical test theory item analysis. For the qualitative analysis, a two-tiered coding protocol was developed to categorize test items. The categories function to identify item where the correct response is selected, but is not supported by reasonable rationale or item where the incorrect response is selected for reasons other than conceptual misunderstanding. Preliminary results show the qualitative protocol supports the results of the classical test theory item analysis. Detailed results along with inter-rater reliability of the coding protocol will be reported.

Cast Iron Spectrometer Standards

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The use of spectrometer standards in the cast iron industry is of great importance in maintaining quality castings. With the onset of shortages to desired standards, there has been a push for standards with chemistry unique to individual foundries. The challenge of this project is developing the process and design equipment necessary to achieve these standards. For a successful casting process; heat must quickly be pulled away from the liquid gray iron poured. The result pursued is to repeatedly pour standards of a specific chemistry and have a chill depth of 0.8 cm or greater. Based on previous research and experimentation, the standards may be produced with the specific requirements necessary for use. The ability to conduct iron pours early in the project was due to a water-cooled heat sink from a senior design project completed by a previous group who attempted the project in 2012. Using this heat sink, data was procured to establish base results, which improved the research component of the project. The first session of pouring standards provided unsuccessful yet extremely useful results. The liquid metal was poured at temperatures ranging between 2500 -2800 degrees Fahrenheit and cooled. White iron chill depth results ranged from 0.4 - 0.7 cm. Although the necessary chill depth is 0.8 cm and greater, this session supplied data regarding the heat transfer from the iron within seconds of pouring onto the copper surface. Using this data we made changes so that the increased pouring temperature, changed geometry and improved surface roughness created standards of ideal chill depth up to 2 cm. The improved standards hardness tested below the required chill depth yield an average Rockwell C Hardness of 47.95 with a standard deviation of 1.4. This hardness quantity is in the appropriate range for white iron where the average is 47.2 as found on matweb.com. White iron is significantly harder than the gray iron metal prior to cooling which has an average hardness of 20. Based on our current results we began creating and evaluating melting processes and equipment; we are now building an improved casting device that isolates the pouring surface of each standard with a single copper heat sink under each four cavities to optimize heat transfer from the liquid iron to complete our goal.

Thermal and Ultraviolet Modeling, Balancing, and Sensing for TSAT

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The Taylor Satellite (TSAT) CubeSat carries a payload of sensors for measuring space weather in extremely low-earth orbit, on a flight path which exposes the sensitive equipment on board to a potentially wide set of temperature extremes. As a result, the Thermal and Ultraviolet Modeling, Balancing, and Sensing project (ThUMBS) is the system of sensors and mathematical models with the primary purpose of ensuring the safe operating temperature of the second generation TSAT 2 -unit CubeSat in ELEO. A secondary goal consists of observing the behavior and influences of this temperature for use and analysis in future studies. ThUMBS is comprised of a modeling subsystem to ensure a 220 K - 310 K target operating range, a thermal sensor array of 16 sensors with 0.5 K resolution, and a UV sensor array capable of monitoring incoming radiation from 100nm to 400nm wavelengths. Tertiary goals include passive observation with the UV arrays of phenomena such as lightning strikes and solar flares, and comparison to data from other TSAT sensor arrays. From the beginning, the project has required networking with professors and students, willingness and flexibility to meet changing project requirements, rigorous measures to ensure system modularity, and full integration of systems and data with other projects. Additionally, every important design decision and failure analysis made has been documented thoroughly, as well as data from two prototype launches on Taylor's High Altitude Research Platform (HARP). Implementation of such a regimented documentation protocol coupled with the software modeling used throughout is believed to be of benefit to enhancing student learning and their overall appreciation of the technological advancements made in the applied sciences.

Nanosatellite Solid State Spectrometer for TSAT

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Along with its other sensors, the Taylor Satellite (TSAT) houses solid state spectrometer to take in-situ measurements of space-weather. With such instrumentation, location specific data throughout the orbital lifetime of the satellite can be ascertained. As an outgrowth of the Engineering Senior Capstone class, student work for the Solid State Detector (SSD) included prototyping the front end circuit and setting up 16 processor counters to track the number of particles detected. The solid state detectors are controlled by a PIC18F2620 microcontroller which collects count data for the solid state detectors and controls a plasma probe circuit. The microcontroller also communicates serially with the instrument processor board. Developing the solid state detectors and processor serves the dual purpose of furthering satellite research and education. Working with a diverse team on a project with real costs, deadlines, requirements, and a real launch with NASA is an invaluable experience. The opportunity to work with the particle detectors has especially provided a unique exposure to the challenges facing circuit debugging and processor algorithm structuring. After integrating the solid state spectrometer and ground testing, a high altitude research project (HARP) balloon was launched to do inflight testing. Based on the results, the system proved the concept for the algorithm and circuitry. Future testing will continue to be conducted. This project has proved a worthy platform for student creativity, discovery, and education.

TSAT Student Embedded Processor (StEP)

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The Taylor Satellite (TSAT) will utilize a student flight processor for on-board data acquisition and transmission. The data from the instrument bay will be packaged in an array, which will then be sent to the main flight processor, and then sent to the ground support equipment. Two student processors will be flown. One will collect UV, thermal, VLF, and E-field data, and another will collect plasma and SSD data. The PIC18F2620 is a familiar processor used in multiple Taylor University balloon and satellite projects. The student flight processor will manage data acquisition and telemetry in order to accomplish TSAT's mission. Developing the student embedded processor serves the dual purpose of furthering satellite research and educational learning objectives. Data acquired on high altitude test balloon launches will verify the functionality of the fully integrated flight software and hardware. Working with a diverse team on a project with real costs, deadlines, requirements, and a real launch with NASA is an invaluable experience to students on the present research mission, and to future students of related learning endeavors.

TSAT Ground Support Equipment Hardware and Software Development

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The mission of the Taylor Satellite (TSAT) is to provide an educational, learning opportunity for students to design and built instruments that measure ionic activity in the extremely low earth orbital region of space, while following the ABET outcomes for the design process. The student sensor bay on TSAT includes distinct instrumentation to measure fields and particles in the relatively unexplored Extremely Low Earth Orbit (ELEO) region. The collected data will be packaged and transmitted by various on-board processors to the ground support equipment (GSE) station. The design and implementation of the GSE software is for the reception and retrieval of data from various student and faculty developed sensors on board the TSAT. This subsystem also involves building GSE hardware, namely a testbench, to control the power supplied to the sensor and microcontroller during the testing phase of its development, with the 34972A LXI Data Acquisition / Data Logger Switch Unit as its driving instrument. The hardware system will also capture important data from each sensor such as voltage and current draws as well as a current draw from the entire student bay. Developing the ground support equipment serves the dual purpose of furthering satellite research and educational learning objectives. Working with a diverse team on a project with real costs, deadlines, requirements, and a real launch with NASA is an invaluable experience to students on the present research mission, and to future students of related learning endeavors.

TSAT Mechanical Boom System

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In addition to the other instruments, the Taylor Satellite (TSAT) includes a dual electronically controlled mechanical boom system. This system is responsible for extending and retracting Very Low Frequency (VLF) sensors up to two meters away from the satellite in opposite directions. This student design is completely original and will greatly increase the functionality of nano-satellites by allowing instruments out on booms rather than antennas alone. The system is greatly simplified by using a layered carbon boom with wire traces pressed onto it. This eliminates the need for wires out to the booms. Building a unique mechanical machine from the ground up is a growing educational experience. The challenges faced through the design process teach lessons that cannot be taught in a classroom, from concept design to troubleshooting prototypes.

Langmuir Probe for Measuring Space Plasma

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The scientific community has a growing interest in space-weather in extremely low orbits. Taylor Satellite (TSAT) will measure these phenomena with an array of sensors, one of which is a Langmuir probe. A Langmuir probe, or plasma probe, takes data tied to its location, thereby uncovering important correlations between particular parts of space and the space-weather. The plasma probe was developed in a senior engineering project class. That effort involved building and testing current and temperature sensing circuits, writing code for a microcontroller to operate the probe, and making hardware and software adjustments so the probe could be integrated into the satellite. The controlling processor reads current and temperature data, then communicates this serially through two more processors. Finally, one of the other processors sends the data back to ground support. A primary motivation for the project is education. Developing the sensor builds individual engineering skills and it creates a valuable basis for any other researcher wishing to study space plasma. Moreover, TSAT provides a project with great research value as well as serious deadlines and costs. Therefore, the project is an invaluable work experience.

TSAT VLF and Electric Field Sensor

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The Earth's Electric Field (ThEEF) sensor will be included on the Taylor Satellite (TSAT) nanosatellite project. This instrument fulfills two roles, a Very Low Frequency (VLF) sensor and an Electric Field (E Field) sensor. The instrument will collect ground breaking data from the lower reaches of the atmosphere, roughly between 300 km and 100 km. This is a cross section that is, surprisingly, not very well understood. As it orbits the earth, it will obtain information about VLF wave propagation characteristics in the region, providing potential fresh insights into the Sun/Earth coupling. It will also measure the vertical voltage per meter, giving the vertical E Field of the Earth. Because of the low cost and many flights to space available, this demonstration could pave the way for underprivileged students to be given the opportunity for hands on engineering experience they wouldn't otherwise have. The poster will also present results on the end-to-end integrated system from two high altitude balloon flights which served as instrumentation testing platforms. This opportunity has provided invaluable experience in the field of space systems and has allowed students to work on a project with real deadlines, costs, requirements.

Development of a Computer Program for Wind Tunnel Design

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Designing and building a wind tunnel is not a simple task. The purpose of this project is to develop a computer program that will simplify this task. This program outputs an optimized open-circuit wind tunnel design based on user needs. The outputs from this program will help design wind tunnels for educational settings. Given a desired test section's velocity and size, the program predicts pressure loss and turbulence intensity. These are the two driving factors in fan or blower selection, screen selection, and honeycomb selection. The geometry of the wind tunnel is also output by the program. An optimized wind tunnel needs to be designed to have straight flow and to run as efficiently as possible. The optimization occurs when the pressure drop and turbulence through the wind tunnel are minimized. Open-circuit wind tunnels are comprised of six sections. Research was done on each of these sections to understand their effects on the turbulence and pressure. An algorithm was developed to determine when the wind tunnel was optimized. Existing wind tunnels' data were compared against the program's outputs. The program is currently in the validation process. The program's outputs will be compared to results from high fidelity computational fluid dynamics. A validation tunnel is being built based on the program's outputs. Physical testing using hot-wire anemometers and pitot tubes will be conducted on the validation tunnel. These three independent tests will verify that the program predicts accurate results. The difficult task of designing wind tunnels will be simplified by the use of this program.

Cascaded Frequency Selective Surfaces

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In this project, we explore the placement of two frequency selective surfaces (FSS) in cascade which act together to shape reflection and transmission characteristics. The structures were simulated using CST Microwave Studio, a full-wave modeling tool. The structures were fabricated by driving a PCB milling machine with Gerber files obtained from the CST FSS simulations. Measurements were carried out in the frequency domain using a 40 GHz Agilent E8363b VNA using an open-air through-line-reflect (TRL) calibration. Measurement results are compared with predictions from simulations. An overview of the theory behind FSS is provided along with some of their current and potential applications and some design guidelines.

Wheelbarrow Machine

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Sponsors:
Krontz General Machine & Tool
JM Equipment
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Wheelbarrows are one of the most widely used tools today. From a garden to the machine shop, they can be found just about anywhere. A wheelbarrow is a small hand-propelled vehicle, designed to be pushed and guided by a single person using two handles to the rear. Many people use wheelbarrows on a daily bases, but they are hard on the body if used over long distances. The first types of self-propelled wheelbarrows were used during ancient times; these were powered by wind through an attached sail. A 7.5 HP engine was selected to modernize and enhance the original design; the goal of this project was to create a low cost, powered wheelbarrow capable of hauling 300 lbs over long distances. Design considerations provided a machine that functions in two ways by walking behind the wheelbarrow or attaching a platform and the operator driving to their destination. The developed prototype features a hinged bucket to allow for easy dumping and strong ergonomic design.

Empowering Future Internet Research and Experimentation Through Active and Programmable Networks

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The shortcomings of today's Internet and the high demand for complex and sophisticated applications and services drive a very interesting and novel research area called Future Internet. The area of Future Internet research focuses on developing a new network with similar magnitude as today's Internet but with more demanding and complex design goals and specifications. It strives to solve the issues identified in today's Internet, by capitalizing on the advantages of emerging new technologies in the area of computer networking such as Software Defined Networking (SDN), Autonomic Computing, and Cloud Computing. These technologies represent an extraordinary opportunity to rethink computer networks, enabling the design and deployment of a future Internet.

This poster outlines the approach used by Purdue University Calumet and Chicago State University to introduce Future Internet research into existing computer networking courses using the Global Environment for Network Innovations (GENI) research framework. The poster discusses the philosophy of how the current Internet limits the flexibility of the network architecture to meet future requirements of the Future Internet. We also present a complete system designed to monitor and enhance a video streaming service based on Transmission Control Protocol (TCP) protocol and runs over an OpenFlow network. The main goal is to show how new technologies such as OpenFlow, Autonomic Computing and Cloud Computing can be combined to meet the complex system requirements of the Future Internet, and how these technologies can help in optimizing a particular Internet service.

The testing environment was built based on deeply programmable OpenFlow switches in the GENI research testbed. The experiments illustrate how how a system designed with new requirements can function under unstable, changing network conditions, how it can dynamically learn its environment to recognize potential service degradation problems and react to these in an autonomic manner without the need for human intervention. In Future Internet, the lossless transmission of data and the efficient utilization of network bandwidth are both highly desired requirements.

Vehicle Crash Detection and Reporting System (Work in progress)

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The widespread adoption of mobile telephony has remarkably improved interpersonal communications in our society. With the generalization of the use of mobile phones emergency calls can be quickly made, but in a severe crash the occupants of a vehicle can be disoriented or unconscious.

This project designs and implements a Mobile Android-based application that monitors the vehicle through an On Board Diagnostics (OBD-II) interface, being able to detect accidents. In order for the application to work correctly, the Android device should at least be able to send SMS or email, include built-in accelerometers and have Internet connection. Although a GPS is not required it is recommended for optimal localization. The application monitors the accelerometer sensors and determining what actions to complete when there is a specific reading. The application should estimate the G force experienced by the passengers in case of a frontal collision, which is used together with airbag triggers to detect accidents. Once the application detects a specific acceleration, it starts a countdown that will last a predefined amount of time (measured in seconds), long enough to give the user the chance to cancel this action in case he or she is not injured.

When completed, this project has the potential to assist many crash victims by performing communication tasks quickly and efficiently for the victim in a time of need, keep loved ones updated by sending SMS messages or emails to them when a crash occurs, and save lives by alerting emergency services quickly and reliably even if the victim is incapacitated. A vehicle or motorcycle crash can be a traumatic event, and automating the task of alerting family and emergency services with technology will mean one less thing to worry about for the driver and passengers.

Next Generation Fill/Drain Valve

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The current propellant fill/drain valves used on many types of spacecraft are difficult to service after testing. Numerous issues have occurred when trying to service such valves that have caused serious injuries and deaths due to leakage of highly volatile and toxic propellants. GoVentures has a new design for a fill/drain valve that will be serviceable after acceptance testing and installation with reduced hazards. However, this design does not properly align the valve poppet and seats due to uneven spring deformation and tolerance stack up.
The valve design was revised with simulation software to minimize uneven deformation in the spring, and a functional relationship analysis was conducted to reduce tolerance stack up. Additional engineering work ensured proper material selection for valve components. These revisions are necessary to provide GoVentures with a proof-of-design prior to moving forward with the current design.